Digitalization

Modelling & Visualizing Heat shielding effects during a fire

Antea Group

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Heat shielding effects during a fire

- Introduction
- Heat radiation models
- Tools to use
- Examples
- Under development
- Questions

Introduction

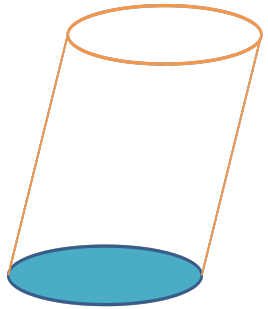
- Industrial fires (outdoors)
  - Tankfire, bundfire, proces equipment fire, truck/trainloading fire, jet fire
- Shielding effects are not often incorporated
  - Can make the difference between approved or disapproved
  - Can save money
- Tools that can take this into account (not limited)
  - CFD
  - Phast
  - GIS (under development)
- Simple shields can make a difference
  - Choose the right material

Heat radiation - Conventional models

- Goal: determine effect distances in an effective and non time-consuming way
- Foundation is laid in: PGS 2/CPR 14 E/"Yellow Book". Collected '80 - '90 by TNO NL
- Used in programs such as Phast, Effects etc.
- 2D in basis

Heat radiation – Conventional models

- Current model:
  - Circular Heat column
  - No interaction with environment
- Physical
  - Evaporation
  - Combustion heat
- Empirical
  - Heat radiation
  - Sooty Flame



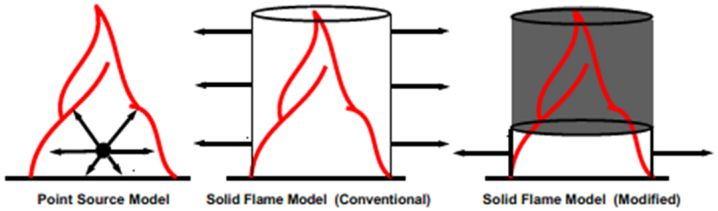
Heat radiation – Conventional models

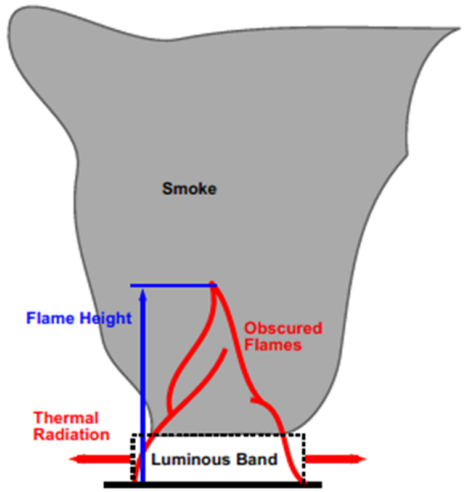
- Burn rate
  - Evaporation rate (heat of vaporisation)
  - Heat released during combustion (Heat of combustion)

- Flame type
  - SEP (Surface Emissive Power)
  - Luminous, smoky and general

Heat radiation – Conventional models

- Flame Types:
  - Luminous
  - Smoky
  - General
- Determines:
  - Maximum surface emissive power,
  - Maximum burn rate,
  - Emissive power length scale,
  - Pool fire burn duration.





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Conventional model limitations!

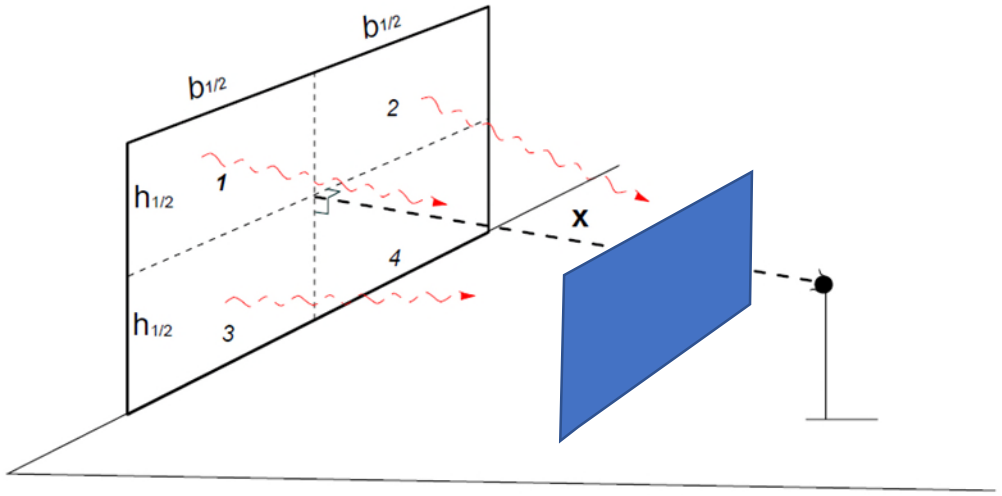
- Choice of substance is essential
- What to do with a mixture of substances?
- Shielding cannot be quantified

Licensed situation determines worst case. Not as build situation

Viewfactor - shielding

The viewfactor is the ratio between received and emitted radiation per unit area.

- the intensity of the radiation source Q (kW/m2);
- the visibility factor Fv(x), which is a function of the distance x from the source



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Heat radiation damage estimate

Heat Flux put in perspective.

Heat Flux (kW/m^2)	Example
1	Sunny day in Greece
2.5	Typical firefighter exposure
3-5	Pain to skin within seconds
20	Threshold flux to floor at flashover
Approx. 60	HC Poolfire edge
60 - 250	Flames over surface

Heat radiation damage estimate

- 12.5 kW/m2 escalation potential for installation (storage tanks, piping, equipment) containing (fire) hazardous substances (IP-19)
- 32 - 37.5 kW/m2 fast escalation potential, within minutes (IP-19)
- 250 kW/m2 potential heat flux within the pool fire (IP-19)
- 350 kW/m2 potential heat flux within a jet fire (IP-19)

But …

Heat radiation damage estimate

Escalation potential depending on:

- % irradiated area (shielding)
- Installation volume (m3)
- Installation content (type of substance)
- Self-cooling power of inventory
- Safety measures (e.g. cooling systems)
- Venting philosophy
- Insulation
- Scenario duration (x minutes)

Tools to use (basic to advanced)

- Excel calculation sheets
- Aloha Cameo (free to use)
- Licenced software (most frequently used):
  - Effects, Shell FRED (GEXCON)
  - Phast (DNV)
- CFD
- GIS applications (under development)

3D	Shielding
No	?
No	No
No	No
Yes	Yes
Yes	Yes
Yes	Yes

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Fire wall height requirement

- Is height sufficient?
- What length?

Berekening straling op doel vanuit bronvlak (stralende gevel, vlamfront)

Gegevens bron

hoogte bronvlak (h1)	8,00	m
breedte bronvlak (b1)	8,00	m
stralingsniveau aan de bron (default 45 kW/m2)	60,00	kW/m2

Gegevens afscherming

afstand afscherming bronvlak (x3)	6,00	m
hoogte afscherming vanaf grondvlak (h3)	3,00	m
breedte afscherming (b3)	2,00	m
locatie afscherming ten opzichte van hartlijn (m3)	-	m

Gegevens beoordelingspunt

locatie punt ten opzichte van hartlijn (m2)	-	m

Let op: als beoordelingspunt en afscherming aan verschillende zijde van Hartlijn, m2 negatief invoeren!

Straling op vaste afstand, met variabele hoogte

afstand tot de bron (x2)	6,50	m
Straling berekenen tot op hoogte van	2,00	m

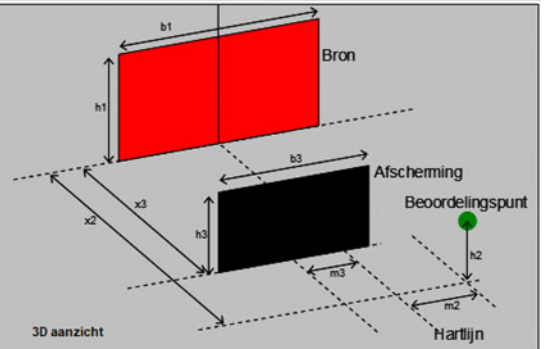
Straling op vaste hoogte, met variabele afstand

Hoogte van het beoordelingspunt (h2)	1,00	m
Straling berekenen tot op afstand van	10,00	m

Resultaten op beoordelingspunt op vaste afstand

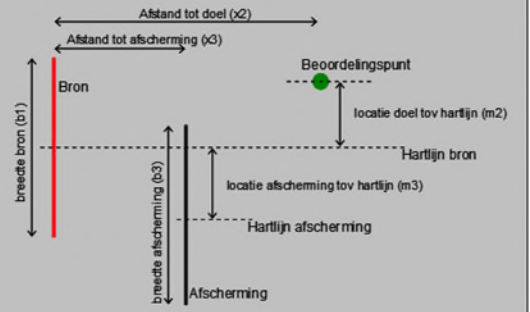
maximale straling op beoordelingspunt zonder afscherming	17,7	kW/m2
op een hoogte van	2,0	m
Maximale straling op beoordelingspunt met afscherming	0,0	kW/m2
op een hoogte van	1,0	m

Grafische resultaten worden gegeven in de twee aanvullende tabbladen



3D aanzicht

Bovenaanzicht



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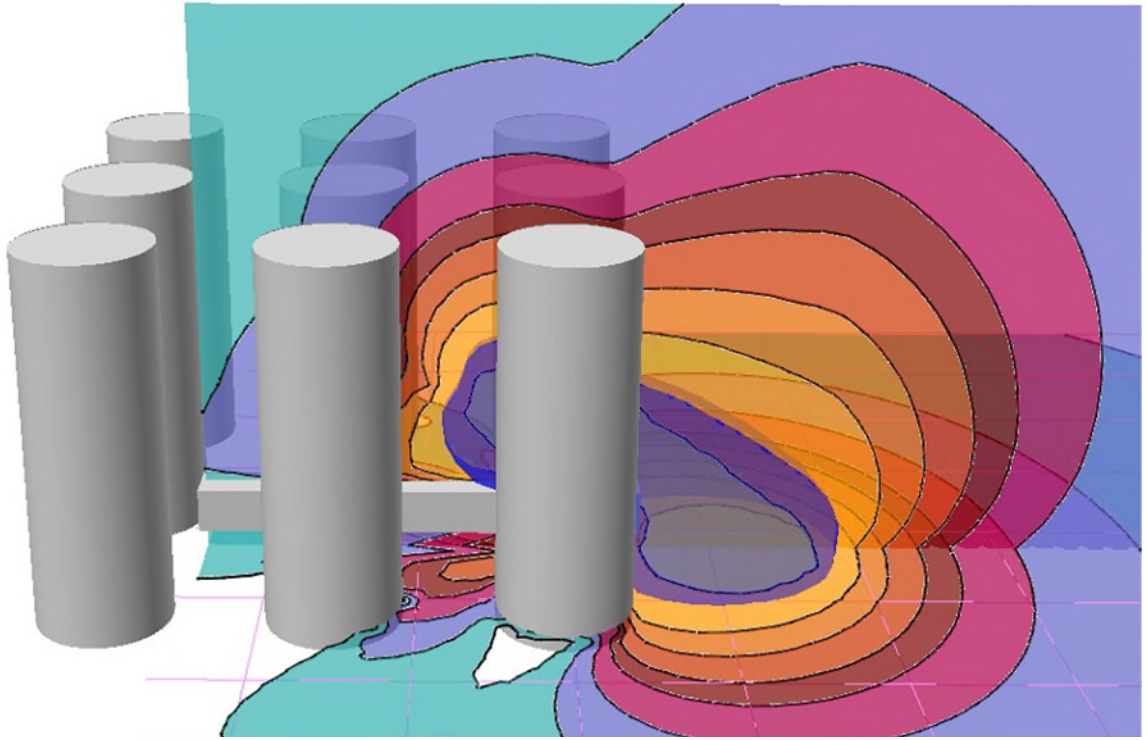
Storage tanks cooling requirements

- Is cooling water capacity sufficient?
- Shielding effect needs to be determined



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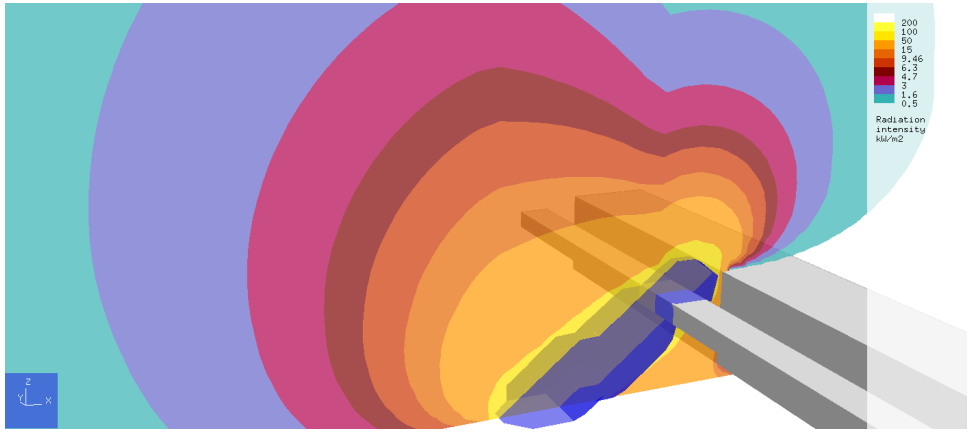
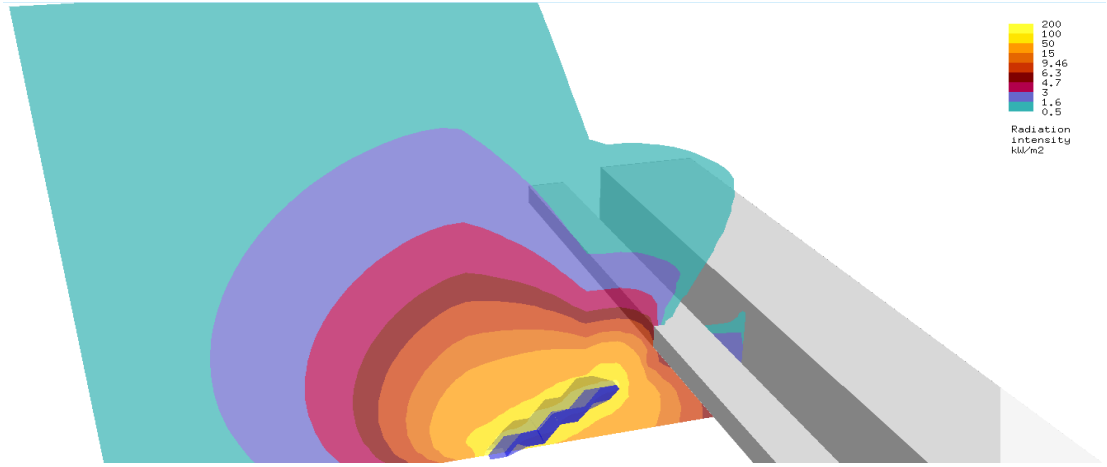
Pipe rack shielding effects

- Main pipe rack contains hazardous pipelines
- Is additional protection required?





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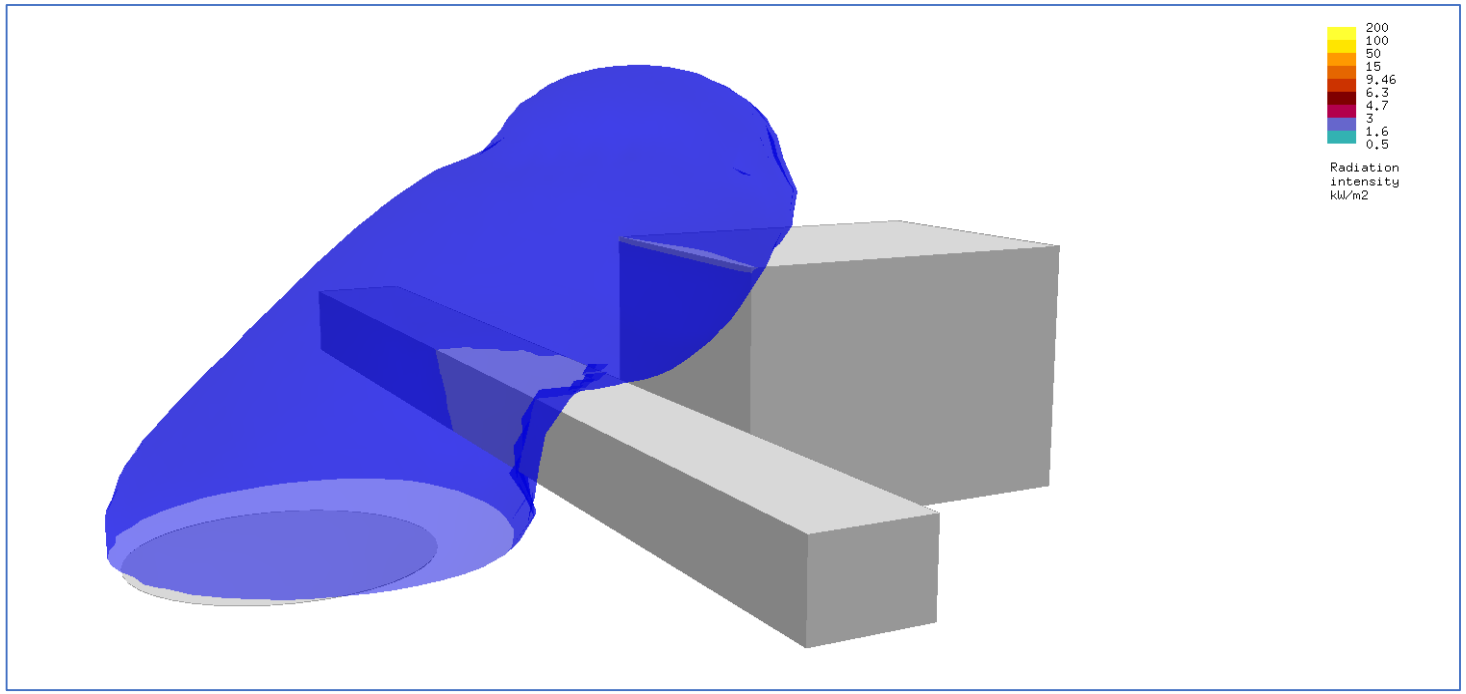
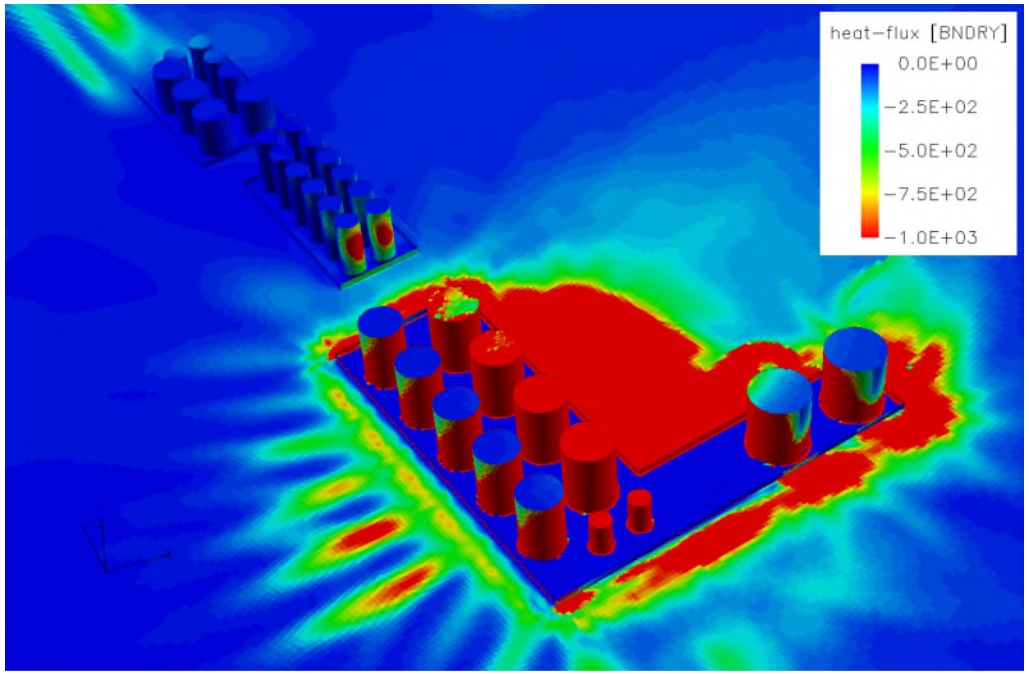
Pipe rack shielding effects

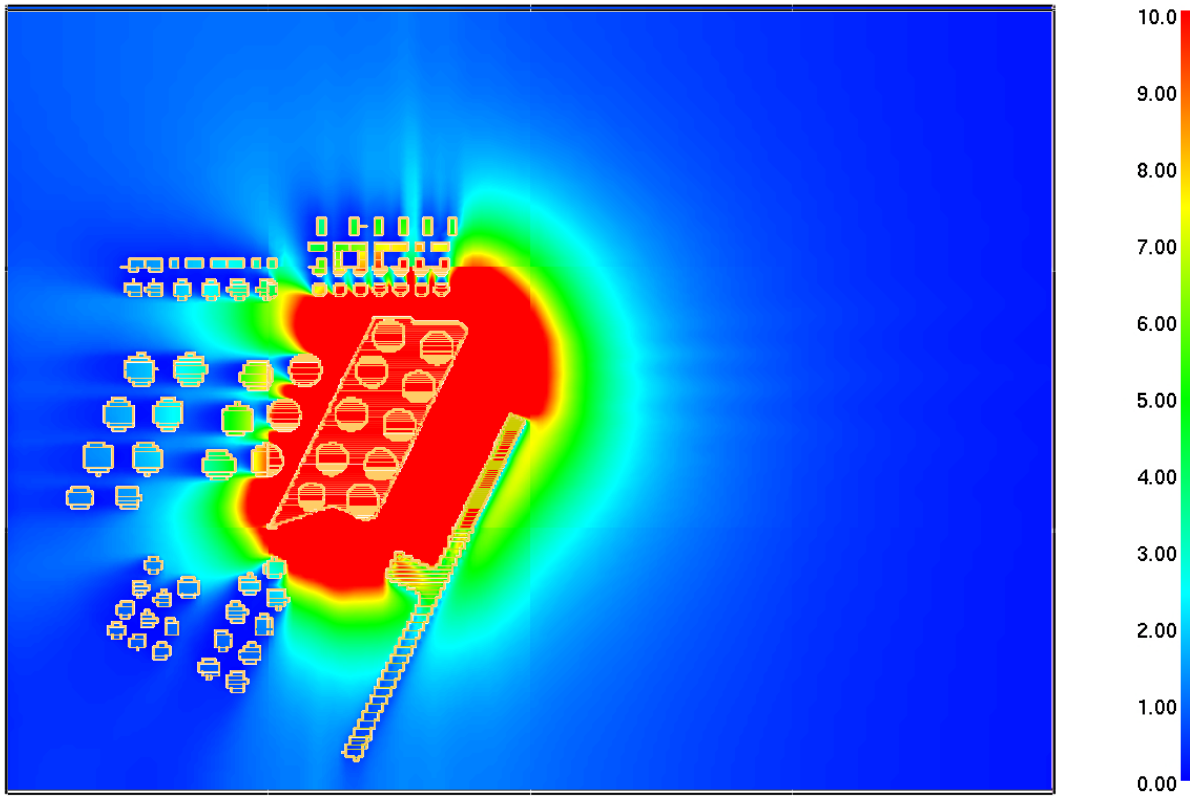
- Building receiving heat radiation contains hazardous equipment
- Without shielding effect heat radiation levels to high



Example CFD – Shielding effect

- CFD simulations can be more precise.





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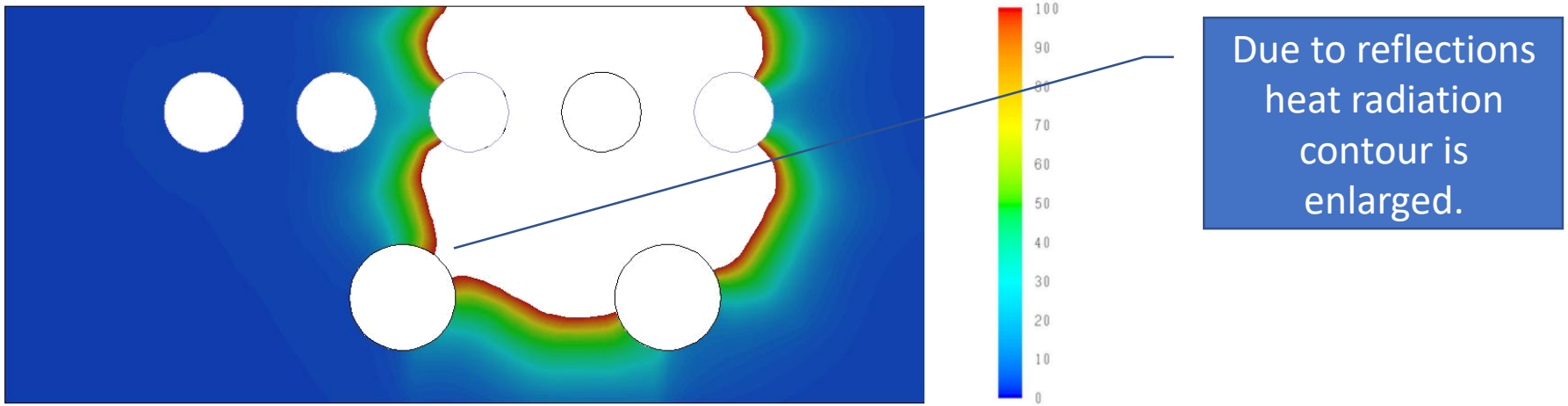
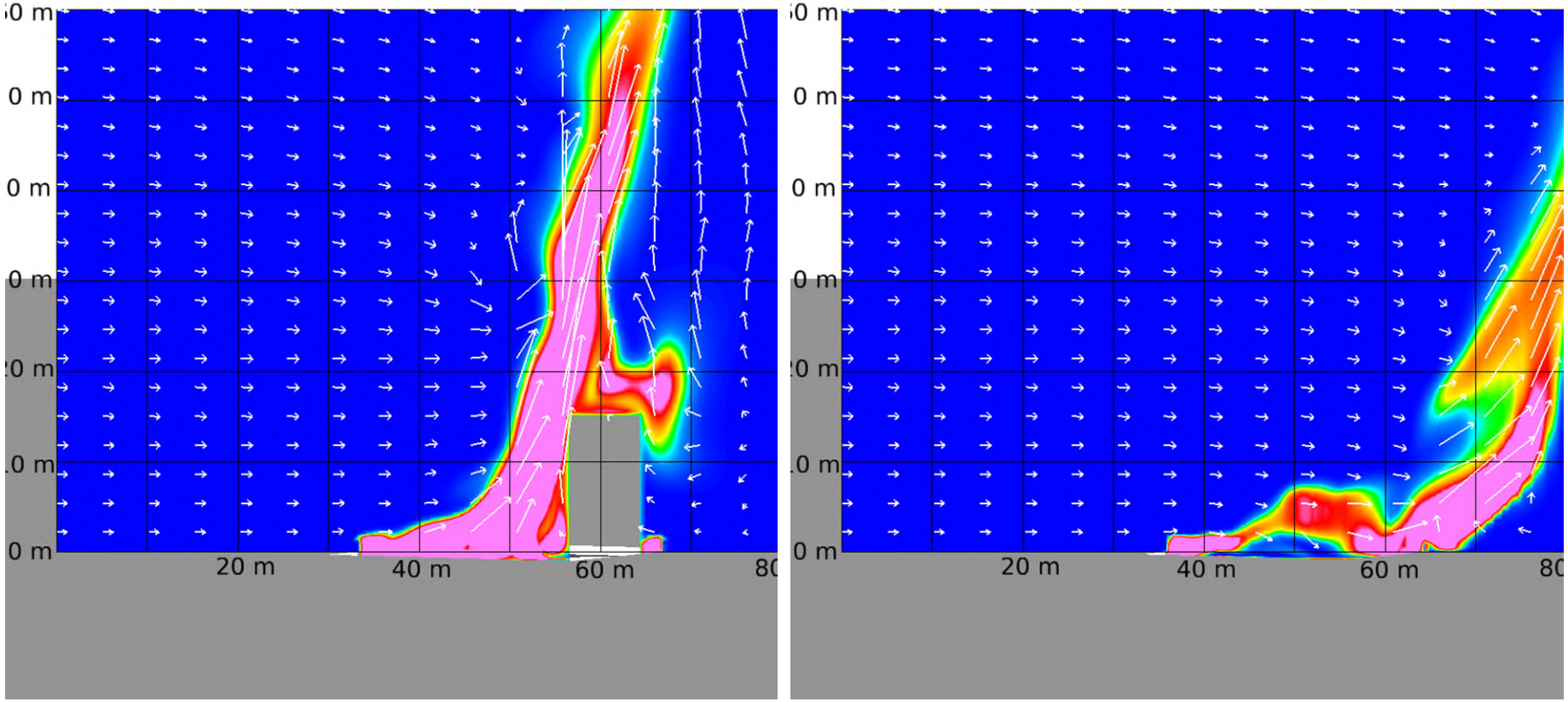
Example CFD – Reflection effect

- Reflections can cause extra attention areas



Example CFD - Channel effect

High objects will channel the flames upward



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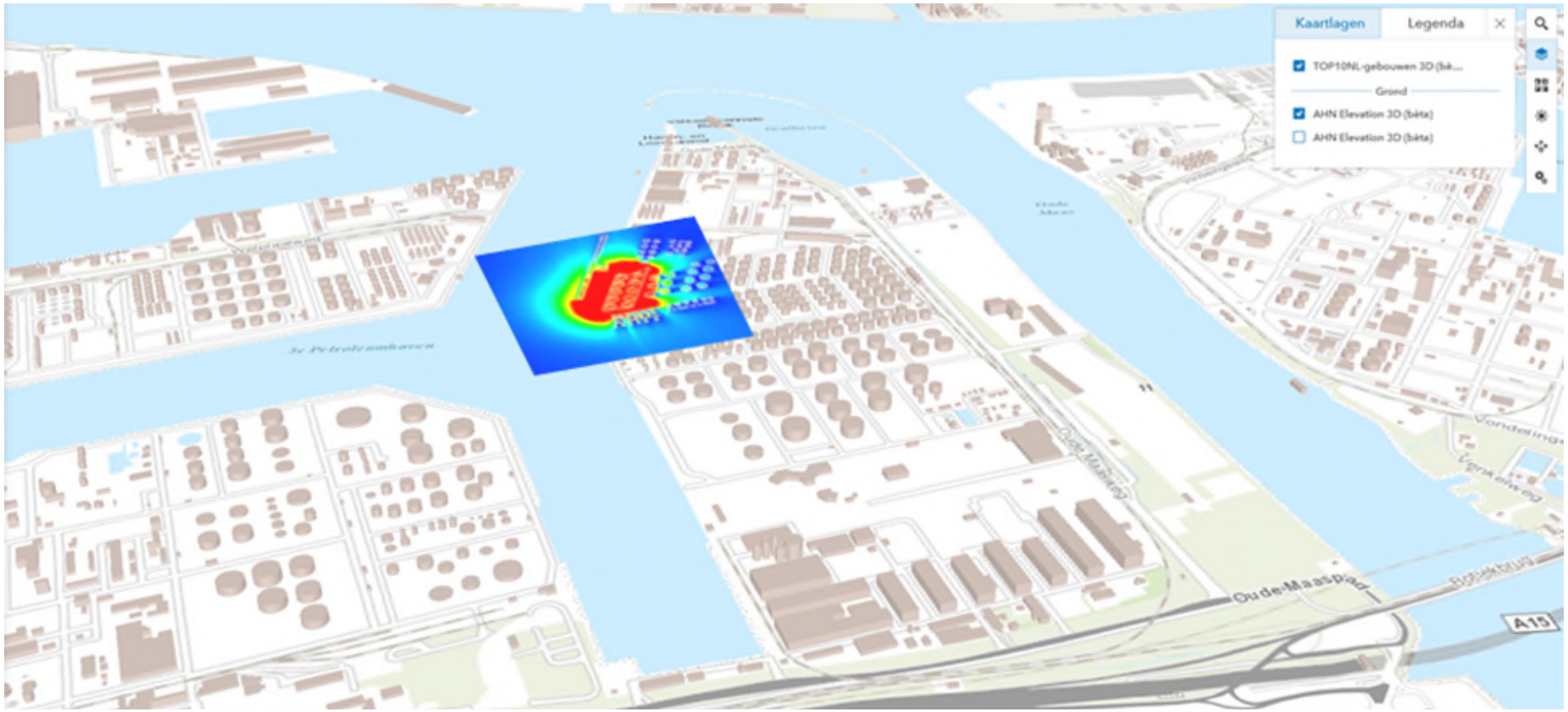
Under development – GIS tooling



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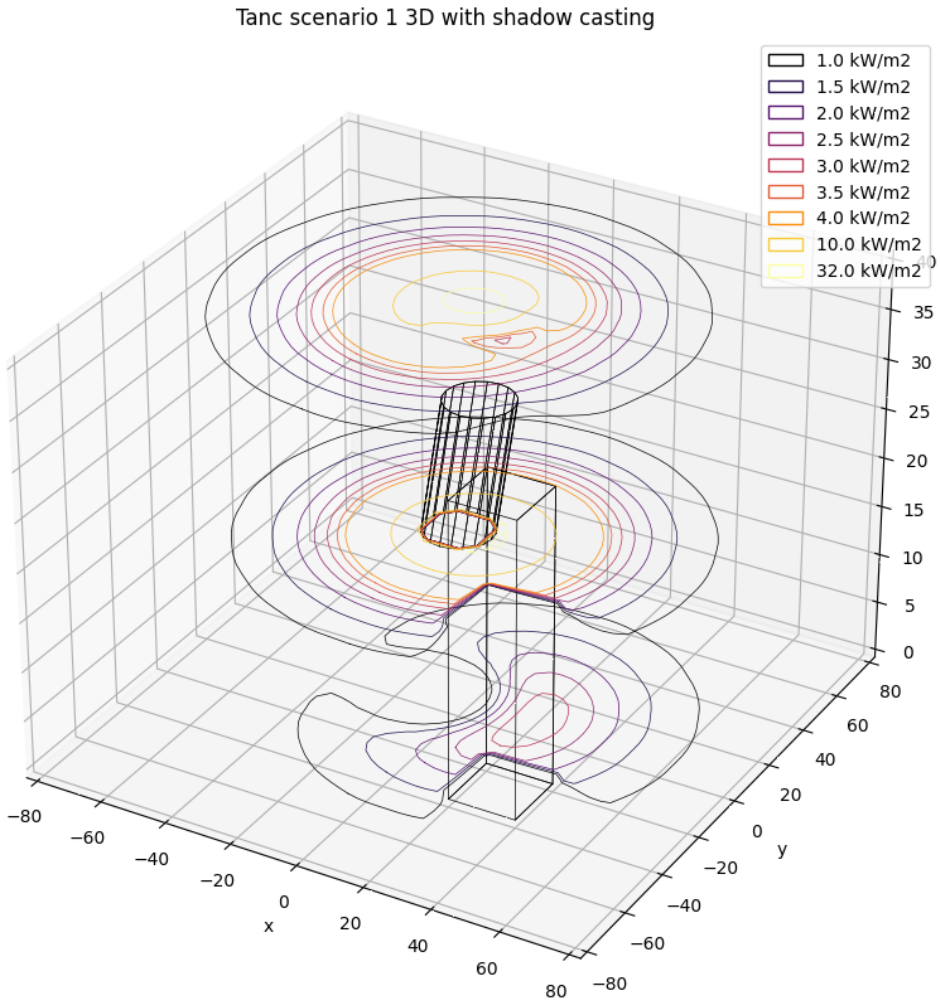
Effect module in ArcGIS online



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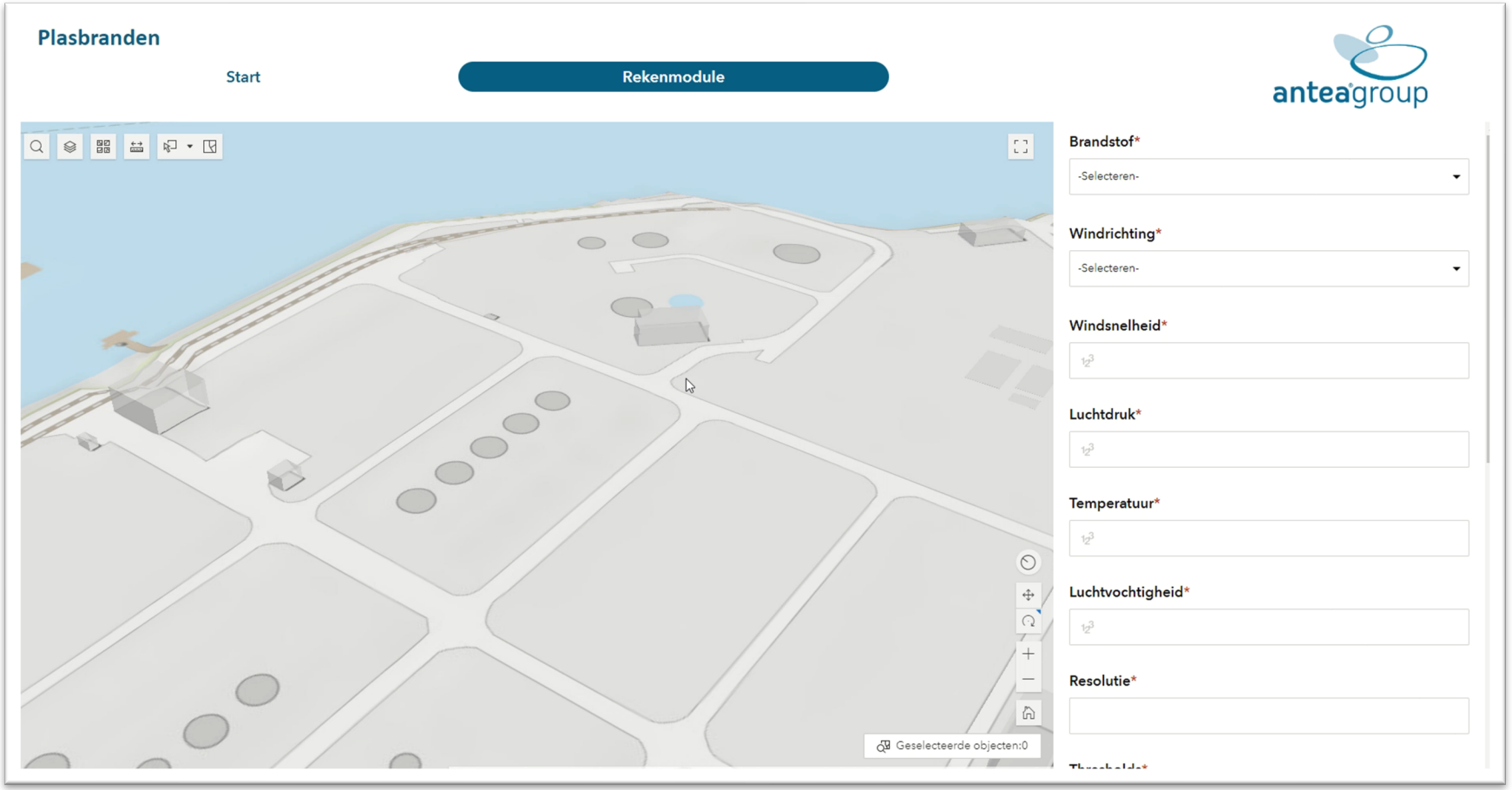

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